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Proposed Best Demonstrated and Available Technology (BDAT) Background Document for Wastes from the Production of Epichlorohydrin K017. Volume 4

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This background document provides the Agency's rationale and technical support for selecting the constituents for proposed regulation in K017 and for developing treatment standards for these constituents. The document also provides waste characterization data that serve as a basis for determining whether a variance from a treatment standard may be warranted for a particular type of K017 that is more difficult to treat than the wastes that were analyzed in developing the treatment standards for K017.

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PROPOSED

BEST DEMONSTRATED AND AVAILABLE TECHNOLOGY (BDAT)

BACKGROUND DOCUMENT

FOR

WASTES FROM THE PRODUCTION OF

EPICHLOROHYDRIN

K017

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Note: This proposed Background Document is being issued in support of the Agency's proposed rulemaking for the land disposal restrictions program. The Agency solicits comments on the proposed rule and on this proposed Background Document. This document will be issued in final form, appropriately revised in response to comments, at the time of promulgation of the final rule.

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1.0 INTRODUCTION

The U.S. Environmental Protection Agency (EPA) is proposing to establish best demonstrated available technology (BDAT) treatment standards for the listed hazardous waste identified in Title 40, Code of Federal Regulations, Section 261.32 (40 CFR 261.32) as K017, heavy ends (still bottoms) from the purification column in the production of epichlorohydrin. These BDAT treatment standards are being established in accordance with the amendments to the Resource Conservation and Recovery Act (RCRA) of 1976, enacted by the Hazardous and Solid Waste Amendments (HSWA) of November 8, 1984. BDAT treatment standards will be effective no later than May 8, 1990, and on and after the effective date, compliance with these BDAT treatment standards will be a prerequisite under 40 CFR Part 268 for placement of the wastes in land disposal units.

This background document provides the Agency's rationale and technical support for selecting the constituents for proposed regulation in K017 and for developing treatment standards for these constituents. The document also provides waste characterization data that serve as a basis for determining whether a variance from a treatment standard may be warranted for a particular type of K017 that is more difficult to treat than the wastes that were analyzed in developing the treatment standards for K017.

The Agency's legal authority and promulgated methodology for establishing treatment standards and the petition process necessary for requesting

a variance from the treatment standards are summarized in EPA's Methodology for Developing BDAT Treatment Standards (Reference 8).

This background document presents the following waste-specific information: the numbers and locations of facilities that may be affected by the land disposal restrictions for K017; the processes generating this waste; waste characterization data; the technologies used to treat this waste (or similar wastes, if any); and the treatment performance data on which the proposed treatment standards are based. This document also explains how EPA determines BDAT, selects constituents for regulation, and calculates treatment standards.

Under 40 CFR 261.32, wastes identified as K017 are listed as follows:

K017 - Heavy ends (still bottoms) from the purification column in the production of epichlorohydrin.

The Agency believes that there are three facilities manufacturing epichlorohydrin in the United States that could potentially generate this listed waste.

The Agency is proposing to regulate three organic constituents in K017 nonwastewaters and wastewaters. No metal constituents are being proposed for regulation in K017 nonwastewaters and wastewaters. To determine the applicability of the proposed treatment standards, wastewaters for K017 are defined as wastes containing less than 1% (weight basis) total suspended

solids[1] and less than 1% (weight basis) total organic carbon (TOC). Wastes not meeting this definition are classified as nonwastewaters and would have to comply with the promulgated nonwastewater treatment standards.

The Agency does not have any performance data for treatment of K017. Treatment performance tests for these wastes have not been pursued since EPA-approved analytical methods are not available for some of the constituents of concern in K017. Additionally, the Agency believes that adequate treatment performance data are available for other constituents of concern (that do have EPA-approved analytical methods) from similar wastes previously tested by the BDAT program. Therefore, the Agency is proposing to transfer such data from another previously tested waste, F024, to K017 to develop proposed treatment standards for K017 nonwastewaters and wastewaters.

For K017 nonwastewaters, proposed BDAT treatment standards for organic constituents are based on treatment performance data transferred from the ash residual from incineration of F024.

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[1]The term "total suspended solids" (TSS) clarifies EPA's previously used terminology of "total solids" and "filterable solids." Specifically, total suspended solids is measured by Method 209C (total suspended solids dried at 103-105°C) in Standard Methods for the Examination of Water and Wastewater, Sixteenth Edition (Reference 10).

For K017 wastewaters, proposed BDAT treatment standards for organic constituents are based on treatment performance data transferred from the scrubber water residual from incineration of F024.

Table 1-1 lists the proposed treatment standards for K017 nonwastewaters and wastewaters. Treatment standards for organic constituents proposed for regulation in K017 nonwastewaters and wastewaters are based on the total concentration of each constituent in the waste.

The units used for total constituent concentration of organic constituents in K017 nonwastewaters are mg/kg (parts per million on a weight-by-weight basis). The units used for total constituent concentration of organic constituents in K017 wastewaters are mg/l (parts per million on a weight-by-volume basis). If the concentrations of the constituents proposed for regulation in K017 nonwastewaters and wastewaters, as generated, were lower than or equal to the proposed treatment standards, then treatment of the waste would not be required prior to land disposal.

Table 1-1

PROPOSED BDAT TREATMENT STANDARDS FOR K017

NONWASTEWATERS AND WASTEWATERS

	Maximum for Any Single Grab Sample	
BDAT List Constituent	Total Concentration Nonwastewaters (mg/kg)	Total Concentration Wastewaters (mg/l)
26. 1,2-Dichloropropane	0.014	0.014
49. 1,2,3-Trichloropropane	0.014	0.014
68. Bis(2-chloroethyl)ether	1.78	0.037

2.0 INDUSTRY AFFECTED AND WASTE CHARACTERIZATION

This section describes the industry affected by the land disposal restrictions for K017 and presents available characterization data for this waste.

Under 40 CFR 261.32 (hazardous wastes from specific sources), wastes identified as K017 are listed as follows:

K017: Heavy ends (still bottoms) from the purification column in the production of epichlorohydrin.

2.1 Industry Affected and Process Description

The Agency estimates that there are three domestic facilities that produce and purify epichlorohydrin and may potentially generate K017. Table 2-1 lists the facilities by state and EPA region. These facilities were identified using the updated TSDR survey database as well as data collected during EPA's listing efforts for K017.

Epichlorohydrin is used mainly as an intermediate for the manufacture of glycerin and epoxy resins. It is also used in the manufacture of plasticizers, surfactants, stabilizers, and ion exchange resins.

Heavy ends (still bottoms) from the purification column in the production of epichlorohydrin is the waste stream of concern addressed in this

Table 2-1

FACILITIES THAT MAY GENERATE K017, BY STATE AND EPA REGION

Facility	Location	EPA Region
Dow Chemical	Freeport, TX	VI
Shell Oil Co.	Deer Park, TX	VI
Ciba-Geigy Corp.	Toms River, NJ	II

document. A simplified flow diagram illustrating the manufacturing process generating epichlorohydrin is presented in Figure 2-1.

Epichlorohydrin is produced by the following reaction sequence:

Step 1:

Cl_2 (chlorine) + H_2O (water) --------> HOCl (hypochlorous acid) + HCl (hydrochloric acid)

Step 2:

CH_2-CH-CH_2Cl (allyl chloride) + HOCl / HCl (hypochlorous acid and hydrochloric acid) ---------> $CH_2OHCHClCH_2Cl$ (65-70%) (1,2-dichloropropanol-1) + $CH_2ClCHOHCH_2Cl$ (30-55%) (1,3-dichloropropanol-2)

Step 3:

$CH_2OHCHClCH_2Cl$ (1,2-dichloropronanol-1) + $CH_2ClCHOHCH_2Cl$ (1,3-dichloropropanol-2) + 2NaOH ---------> $2CH_2$-CH-CH_2Cl (epichlorohydrin) +2NaCl +$2H_2O$

By-products produced in small quantities are 1,2,3-trichloropropane and chloro-ethers.

As shown in Figure 2-1, a mixture of hypochlorous acid and hydrochloric acid reactants is produced by absorbing chlorine in water in the chlorine absorber. The resulting hypochlorous acid feed plus allyl chloride are then fed to the chlorination reactor. After chlorination, the reaction mixture (containing the dichloropropanols, some feed materials, and reaction by-products) is sent to a separator. The top aqueous layer containing hydrochloric and hypochlorous acids is then recycled to the chlorine absorber;

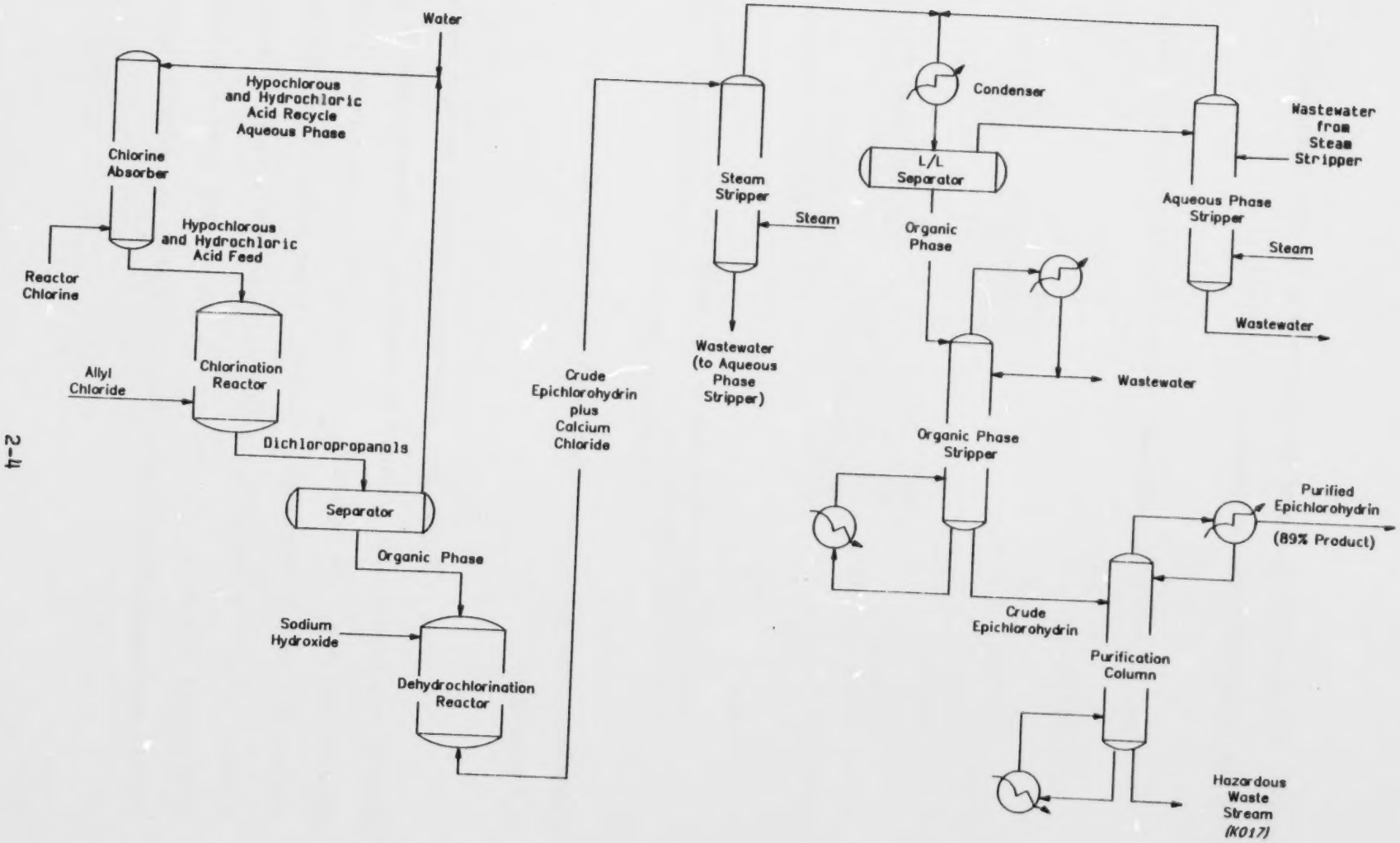

Figure 1. Production of Epichlorohydrin (K017)

the bottom organic phase is sent to the dehydrochlorination reactor where the dichloropropanols are dehydrochlorinated using sodium hydroxide.

The crude epichlorohydrin and calcium chloride mixture from the dehydrochlorination reactor is sent to a steam stripper. In the steam stripper an azeotropic mixture is formed consisting of water and crude epichlorohydrin. This mixture is taken overhead, condensed, and sent to a liquid/-liquid separator.

The wastewater from the bottom of the steam stripper is stripped in the aqueous phase stripper where small amounts of epichlorohydrin are recovered overhead and recycled to the steam-stripper condenser; the bottom stream is discharged as wastewater.

The bottom organic phase from the liquid/liquid separator is fed to the organic phase stripper where residual water is removed overhead. The bottom stream of crude epichlorohydrin is fed to a purification column where it is purified by fractionation. Purified epichlorohydrin is distilled overhead. The bottom stream from the purification column is the waste stream of concern (K017) in this document.

2.2 Waste Characterization

Table 2-2 presents a summary of the available characterization data for K017. Data are presented for BDAT List constituents and other compounds

Table 2-2

SUMMARY OF AVAILABLE CHARACTERIZATION DATA FOR K017

BDAT List Constituents	Untreated Waste Concentration (%) Source a	Source b
26. 1,2-Dichloropropane	0.1-1	-
49. 1,2,3-Trichloropropane	<0.01-70	70
68. Bis(2-chloroethyl)ether*	14	14
Other Constituents		
Bis(2-chloromethyl)ether*	14	14
Epichlorohydrin	<0.01-10	2
Dichloropropanol	0-10	10
Bis-dichloropropyl ether	<0.01-50	-
Bis-tetrachloropropyl ether	10-50	-
Chlorinated Aliphatics	4	4
Chloroallyl alcohol	<0.01-1	-
1-Chloropropane	0.1-1	-
2-Chloropropane	0.1-1	-

Sources: a Environ Report (Reference 18).
b Listing Background Document for K017 (Reference 6).
* = Concentrations of untreated waste for chloroethers including Bis(2-chloroethyl)ether and Bis(2-chloromethyl)ether combined is 14 percent.
- = Not available.

that are believed to be present or have been detected in K017. The summary in Table 2-2 was compiled using data from the Environ Report (Reference 18) and information collected by EPA as part of the hazardous waste listing of K017 (Reference 6).

As shown in Table 2-2, K017 contains several organic constituents of concern that could be present at concentrations up to 70%. The constituents of concern based on the listing of K017 are 1,2-Dichloropropane, 1,2,3-Trichloropropane, Bis(2-chloroethyl)ether, Bis(2-chloromethyl)ether, epichlorohydrin, and dichloropropanol. This waste is not expected to contain metals based on engineering judgement of the process generating the waste.

3.0 APPLICABLE AND DEMONSTRATED TREATMENT TECHNOLOGIES

This section identifies the treatment technologies that are applicable for treatment of K017 and determines which of the applicable technologies can be considered demonstrated for the purpose of establishing BDAT.

To be applicable, a technology must theoretically be usable to treat the waste in question or to treat a waste that is similar in terms of parameters that affect treatment selection. (Detailed descriptions of technologies that are applicable to listed hazardous wastes are provided in EPA's Treatment Technology Background Document (Reference 9).) To be demonstrated, a technology must be employed in full-scale operation for the treatment of the waste in question or of a similar waste. Technologies available only at pilot- or bench-scale operations are not considered in identifying demonstrated technologies.

3.1 Applicable Treatment Technologies

Since K017 contains high concentrations of organic compounds (Section 2.0), applicable treatment technologies include those that destroy, reduce, or recover the total amount of various organic compounds in the waste. The Agency has identified the following treatment technologies as applicable for K017: (1) incineration (fluidized-bed, rotary kiln, and liquid injection); (2) solvent extraction (including critical fluid extraction) followed by incineration or recycle of the extract; and (3) total recycle or reuse.

These treatment technologies were identified based on current literature sources, field testing, and current waste treatment practices.

Incineration. Incineration is a destruction technology in which energy, in the form of heat, is transferred to the waste to destabilize chemical bonds and destroy hazardous organic constituents. In a fluidized-bed incinerator, waste is injected into the fluidized-bed material (generally sand and/or incinerator ash), where it is heated to its ignition temperature. Heat energy from the combustion reactions is then transferred back to the fluidized-bed. Ash is removed periodically during operation and during bed change-outs.

In a rotary kiln incinerator, waste is fed into the elevated end of the kiln, and the rotation of the kiln mixes the waste with hot gases to heat the waste to its ignition temperature. Ash is removed from the lower end of the kiln. Combustion gases from the kiln enter the afterburner for complete destruction of waste constituents. Other waste may also be injected into the afterburner.

In a liquid injection incinerator, liquid wastes are atomized and injected into the incinerator. In general, only wastes with low or negligible ash content are amenable to liquid injection incineration. Therefore, this technology generally does not result in the generation of an ash residual.

Combustion gases from the incinerator are then fed to a scrubber system for cooling and removal of entrained particulates and acid gases, if present. In general, with the exception of liquid injection incineration, two residuals are generated by incineration processes: ash and scrubber water.

Solvent Extraction. Solvent extraction is a separation technology in which organics are removed from the waste due to greater constituent solubility in the solvent phase than in the waste phase. This technology results in the generation of two treatment residuals: a treated waste residual and an extract. The extract may be recycled or treated by incineration.

Critical Fluid Extraction. Critical fluid extraction is a solvent extraction technology in which the solvent is brought to its critical state to aid in the extraction of hazardous organic constituents from the wastes. After the extraction step, the solvent (liquified gas at its critical state) is brought back to its normal condition in the gaseous state, generating a small volume of extract that is concentrated in hazardous organic constituents. This technology results in the generation of two treatment residuals: a treated waste and an extract. The extract may be recycled or treated by incineration.

Total Recycle or Reuse. Total recycle or reuse of a waste in the same process or another process eliminates the generation of the waste and generates no treatment residuals.

3.2 Demonstrated Treatment Technologies

The Agency has identified incineration (including rotary kiln, liquid injection, and fluidized-bed incineration) and total recycle or reuse as the demonstrated treatment technologies for K017 nonwastewater and its nonwastewater residuals. The Agency is not aware of any facilities that treat, on a full-scale operational basis, K017 or similar wastes using solvent extraction or critical fluid extraction; therefore, EPA believes that solvent extraction and critical fluid extraction are not currently demonstrated for K017. The Agency is also not aware of any facilities that treat wastewater forms of K017.

Incineration

Rotary kiln incineration is demonstrated on a full-scale operational basis for treatment of K107 at at least one facility. Liquid injection incineration is demonstrated on a full-scale operational basis for treatment of a similar waste at at least four facilities. In addition, fluidized-bed incineration is demonstrated on a full-scale operational basis for treatment of a similar waste at at least one facility.

Total Recycle or Reuse

EPA is aware of at least one facility that reuses K017 as feed to a thermal oxidation unit that produces acid and heat.

4.0 TREATMENT PERFORMANCE DATA

The Agency does not have any treatment performance data for treatment of K017 nonwastewaters and wastewaters. Therefore, treatment performance data were transferred from another previously tested waste to develop proposed treatment standards for K017 nonwastewaters and wastewaters. The basis for data transfer and the sources of treatment performance data are discussed below.

EPA's methodology for transfer of treatment performance data is provided in EPA's Methodology for Developing BDAT Treatment Standards (Reference 8). Transfer of treatment performance data is technically valid in cases where the untested waste is generated from a similar industry or similar processing step, or has similar waste characteristics affecting treatment performance and treatment selection, as the tested wastes. Sources of treatment performance data for potential transfer to K017 nonwastewaters and wastewaters include wastes previously tested by rotary kiln, fluidized-bed, or liquid injection incineration. (This technology was identified as applicable and demonstrated for treatment of K017 in Section 3.0).

Treatment of Organic Constituents

Incineration. Wastes previously tested by the Agency by rotary kiln, fluidized-bed, or liquid injection incineration include: K001, K019, K024, K037, K086, K087, K101, K102, F024, K048, and K051. EPA examined these

wastes to identify the best data source(s), if any, for transfer of treatment performance data to K017 nonwastewaters and wastewaters. Specifically, EPA examined whether the untested waste is (1) generated from similar industries or processing steps, and (2) whether the waste has similar waste characteristics affecting treatment performance as these previously tested wastes.

Of the wastes previously tested by incineration, two wastes, F024 and K019 are believed to be similar to K017. F024 and K019 are generated from the chlorinated organic chemicals industry and are also generated by distillation, filtration, or some other type of separation process from the product stream. K019 is generated from the production of chlorinated ethanes and contains high concentrations of these constituents. F024 is generated from the production of chlorinated organic chemicals having a carbon content consisting of one to five carbons and contains high concentrations of these types of compounds. In addition, F024 contains high concentrations of the three BDAT List constituents present in K017. K019 contains only one of the BDAT List constituents contained in K017 and at a lower concentration than that in F024.

As discussed in the Treatment Technology Background Document (Reference 9), waste characteristics that affect treatment performance for rotary kiln, fluidized-bed, and liquid injection incineration include the thermal conductivity of the waste and the boiling points and bond dissociation energies of the constituents of concern. (Boiling points and bond dissociation energies of the constituents of concern in K017 are provided in Appendix A.)

K017 is a sludge as generated and is expected to have a similar thermal conductivity to F024 and K019. The three BDAT List constituents in K017 are also present in F024 and one is present in K019. Thus, the BDAT List constituents in K017 would have the same boiling points and bond dissociation energies as those same constituents in F024 and K019. Therefore, based on thermal conductivity, boiling points, and bond dissociation energies, K017 is expected to be no more difficult to treat than either F024 or K019.

Characterization data for K017 shows that K017 nonwastewaters are comprised primarily of 1,2-dichloropropane, trichloropropane, bis(2-chloroethyl)ether, bis(2-chloromethyl)ether, epichlorohydrin, and dichloropropanol. The BDAT List constituents 1,2-dichloropropane, trichloropropane, and bis(2-chloroethyl)ether were also found in untreated F024 at concentrations of up to 23%, 0.9%, and 0.9% respectively. The only matching BDAT List constituent found in untreated K019 was bis(2-chloroethyl)ether at a concentration up to 340 ppm (0.034%).

Based on the similarities discussed above, proposed treatment standards for organic BDAT List constituents in K017 nonwastewaters and wastewaters were developed from treatment performance data transferred from rotary kiln incineration of F024.

Table 4-1 presents all BDAT List constituents detected in the untreated F024 collected by EPA for the F024 rotary kiln incineration test. (All tables are presented at the end of this section.) Table 4-2 presents all

BDAT List constituents detected in the kiln ash residual, and Table 4-3 presents all BDAT List constituents detected in the scrubber water residual. Design and operating data for the rotary kiln and the secondary combustor are presented in Table 4-4.

Table 4-1

WASTE CHARACTERIZATION DATA COLLECTED BY EPA FOR F024 FROM PLANTS[a] A, B, C, AND D TREATED BY ROTARY KILN INCINERATION

BDAT List Constituent	Concentration in Untreated Wastes[b] Fed to the Rotary Kiln		Concentration in Untreated Wastes[b] Fed to the Secondary Combustor	
	Plant C (ppm)	Plant D (ppm)	Plant A (ppm)	Plant B (ppm)
222. Acetone	<0.05	<500	21,000	<20,000
10. 2-Chloro-1,3-butadiene	<0.5	<5,000	139,721	<200,000
14. Chloroform	<0.025	<250	<1,000	<10,000
16. 3-Chloropropene	<0.5	<5,000	<20,000	285,486
20. trans-1,4-Dichloro-2-butene	<0.5	<5,000	2,112	<200,000
23. 1,2-Dichloroethane	<0.25	11,000	<1,000	<10,000
26. 1,2-Dichloropropane	<0.025	<250	<1,000	230,000
27. trans-1,3-Dichloropropene	<0.025	<250	<1,000	290,000
28. cis-1,3-Dichloropropene	<0.025	<250	<1,000	160,000
34. Methyl ethyl ketone	<0.05	<250	2,200	<20,000
38. Methylene chloride	<0.025	<250	<1,000	<10,000
42. Tetrachloroethene	0.3	<250	<1,000	<10,000
43. Toluene	<0.025	<250	<1,000	<10,000
45. 1,1,1-Trichloroethane	<0.025	<250	<1,000	<10,000
46. 1,1,2-Trichloroethane	<0.025	860	<1,000	<10,000
49. 1,2,3-Trichloropropane	<0.025	<250	<1,000	9,712
59. Benz(a)anthracene	0.89	<0.351	<172	<189
62. Benzo(a)pyrene	0.6	<0.351	<172	<189
63. Benzo(b)fluoranthene	0.72	<0.351	<172	<189
64. Benzo(ghi)perylene	0.42	<0.351	<172	<189

Note: The variation in detection limits for the same constituent was caused by the variation in the waste matrices.

NA - Not analyzed.

[a]Plant codes are listed in Appendix B.

[b]F024 from Plants A and B were liquids; F024 from Plants C and D were sludges.

Table 4-1 (Continued)

WASTE CHARACTERIZATION DATA COLLECTED BY EPA FOR F024 FROM PLANTS[a] A, B, C, AND D TREATED BY ROTARY KILN INCINERATION

BDAT List Constituent	Concentration in Untreated Wastes[b] Fed to the Rotary Kiln		Untreated Wastes[b] Fed to the Secondary Combustor	
	Plant C (ppm)	Plant D (ppm)	Plant A (ppm)	Plant B (ppm)
65. Benzo(k)fluoranthene	0.87	<0.351	<172	<189
68. Bis(2-chloroethyl)ether	<0.351	32.4	<172	<189
70. Bis(2-ethylhexyl)phthalate	7.6	0.58	<172	<189
80. Chrysene	1.1	0.41	<172	<189
87. 1,3-Dichlorobenzene	<0.351	<0.351	<172	<189
88. 1,4-Dichlorobenzene	<0.351	2.08	<172	<189
89. 3,3'-Dichlorobenzidine	<1.76	<1.76	<860	<945
92. Diethyl phthalate	0.05	<0.351	<172	<189
110. Hexachlorobenzene	2.1	0.63	<172	<189
113. Hexachloroethane	0.44	<0.351	<172	<189
116. Indeno(1,2,3-cd)pyrene	0.41	<0.351	<172	<189
121. Naphthalene	<0.351	<0.351	<172	<189
141. Phenanthrene	1.27	0.90	<172	<189
142. Phenol	<0.351	<0.351	<172	<189
150. 1,2,4-Trichlorobenzene	<0.351	<0.351	<172	<189
155. Arsenic	<1.0	2.0	<1.0	<1.0
156. Barium	34	6.8	0.27	0.30
158. Cadmium	3.1	<0.4	<0.4	<0.4
159. Chromium (total)	285	57	<0.4	<0.4
160. Copper	45	800	<0.4	<0.4

NA - Not analyzed.

Note: The variation in detection limits for the same constituent was caused by the variation in the waste matrices.

[a] Plant codes are listed in Appendix B.

[b] F024 from Plants A and B were liquids; F024 from Plants C and D were sludges.

Table 4-1 (Continued)

WASTE CHARACTERIZATION DATA COLLECTED BY EPA FOR F024 FROM PLANTS[a] A, B, C, AND D TREATED BY ROTARY KILN INCINERATION

BDAT List Constituent	Concentration in Untreated Wastes[b] Fed to the Rotary Kiln		Untreated Wastes[b] Fed to the Secondary Combustor	
	Plant C (ppm)	Plant D (ppm)	Plant A (ppm)	Plant B (ppm)
161. Lead	9.0	3.8	<0.5	<0.5
162. Mercury	0.19	<0.1	<0.1	<0.1
163. Nickel	318	636	<0.9	<0.9
165. Silver	<0.4	<0.4	<0.4	<0.4
167. Vanadium	1.0	1.3	<0.3	<0.3
168. Zinc	443	92	1.6	0.73
169. Cyanide	<0.49	2.92	<0.43	<0.44
170. Fluoride	1.08	10.5	<0.99	<1.00
171. Sulfide	<4.8	<4.6	9.1	7.8
207. Hexachlorodibenzo-p-dioxins	0.01	0.002	$<1.4\times10^{-6}$	$<5.3\times10^{-7}$
208. Hexachlorodibenzofurans	0.003	0.05	$<7.1\times10^{-7}$	$<2.7\times10^{-7}$
209. Pentachlorodibenzo-p-dioxins	0.002	0.0003	$<1.4\times10^{-6}$	$<5.0\times10^{-7}$
210. Pentachlorodibenzofurans	0.002	0.03	$<5.1\times10^{-7}$	$<2.0\times10^{-7}$
212. Tetrachlorodibenzofurans	0.001	0.01	$<1.6\times10^{-7}$	$<1.6\times10^{-7}$

NA - Not analyzed.

Note: The variation in detection limits for the same constituent was caused by the variation in the waste matrices.

[a] Plant codes are listed in Appendix B.

[b] F024 from Plants A and B were liquids; F024 from Plants C and D were sludges.

Table 4-2

TREATMENT PERFORMANCE DATA COLLECTED BY EPA FROM
ROTARY KILN INCINERATION OF F024 FROM PLANTS A, B, C, AND D

KILN ASH RESIDUAL

BDAT List Constituent	Concentration in Kiln Ash - Total Composition (mg/kg)						
	Sample Set #1	Sample Set #2	Sample Set #3	Sample Set #4	Sample Set #5	Sample Set #6	Range (mg/kg)
21. Dichlorodi-fluoromethane[a]	0.71	1.40	1.50	1.60	1.70	1.40	0.71-1.70
92. Diethyl phthalate[b]	0.67	0.67	0.67	0.60	0.45	1.14	0.45-1.14
170. Fluoride	NA	NA	2.11	NA	NA	NA	2.11
	Concentration in Kiln Ash - TCLP (mg/l)						Range (mg/l)
154. Antimony	0.062	<0.029	<0.029	<0.029	0.042	0.030	<0.029-0.062
155. Arsenic	0.079	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01-0.079
156. Barium	1.64	1.67	1.94	1.78	1.64	1.56	1.56-1.94
157. Beryllium	<0.001	0.002	0.001	0.002	0.002	0.001	<0.001-0.002
158. Cadmium	<0.004	0.037	0.033	0.028	0.016	0.027	<0.004-0.037
159. Chromium (total)	<0.004	0.28	0.29	0.31	0.32	0.13	<0.004-0.32
160. Copper	0.026	6.48	5.37	4.57	4.54	4.80	0.026-6.48
161. Lead	<0.032	1.2	29.3	22.0	21.6	1.25	<0.032-29.3
162. Mercury	0.0002	<0.0002	<0.0002	0.0003	<0.0002	<0.0002	<0.0002-0.0003
163. Nickel	0.24	3.08	3.68	4.45	4.78	5.32	0.24-5.32
167. Vanadium	0.005	0.004	<0.003	0.008	<0.003	0.005	<0.003-0.008
168. Zinc	0.060	1.84	1.90	1.61	1.56	2.78	<0.060-2.78

NA - Not analyzed.
[a]This constituent was also detected in the laboratory blank at 0.27 mg/kg.
[b]This constituent was also detected in the laboratory blank at 0.51 mg/kg.

Table 4-3

TREATMENT PERFORMANCE DATA COLLECTED BY EPA FROM
ROTARY KILN INCINERATION OF F024 FROM PLANTS A, B, C, AND D

SCRUBBER WATER RESIDUAL

BDAT List Constituent	Concentration in Scrubber Water - Total Composition (mg/l)					
	Sample Set #1	Sample Set #2	Sample Set #3	Sample Set #4	Sample Set #5	Sample Set #6
6. Bromomethane	<0.01	<0.01	<0.01	<0.01	<0.01	0.032
12. Chloroethane	<0.01	<0.01	<0.01	<0.01	<0.01	0.031
15. Chloromethane	<0.01	<0.01	<0.01	<0.01	<0.01	0.020
21. Dichlorodifluoromethane	<0.01	<0.01	0.29[a]	0.36[a]	0.40[a]	0.44[a]
50. Vinyl chloride	<0.01	<0.01	<0.01	<0.01	<0.01	0.026
92. Diethyl phthalate	<0.0116	<0.0121	<0.0108	<0.0104	0.057	<0.0107
154. Antimony	11.3	12.3	9.27	10.8	7.94	8.72
155. Arsenic	0.48	<0.2	0.58	0.51	<0.1	<0.5
156. Barium	33.5	18.3	24.7	38.4	27.0	26.8
158. Cadmium	6.62	6.47	6.95	6.63	2.90	4.81
159. Chromium (total)	27.6	32.1	15.1	33.1	24.4	24.8
160. Copper	175	190	107	209	144	158
161. Lead	361	401	433	358	386	371
162. Mercury	0.31	0.20	0.45	0.29	0.42	0.34
163. Nickel	13.7	16.5	14.2	17.3	14.2	13.4
164. Selenium	3.08	1.09	<2.5	<2.5	<5.0	<0.5
165. Silver	10.9	10.7	10.1	9.45	7.12	5.38
167. Vanadium	1.05	1.72	0.37	1.84	1.52	0.97
168. Zinc	160	162	174	179	128	137
170. Fluoride	NA	NA	153	NA	NA	NA
207. Hexachlorodibenzo-p-dioxins	NA	NA	$<7.2 \times 10^{-6}$	NA	NA	NA
208. Hexachlorodibenzofurans	NA	NA	0.0003	NA	NA	NA
209. Pentachlorodibenzo-p-dioxins	NA	NA	$<5.6 \times 10^{-6}$	NA	NA	NA
210. Pentachlorodibenzofurans	NA	NA	0.0001	NA	NA	NA
212. Tetrachlorodibenzofurans	NA	NA	9.6×10^{-6}	NA	NA	NA

NA - Not analyzed.
[a]This constituent was also detected in the laboratory blank at 0.23 mg/l.

Table 4-4

DESIGN AND OPERATING DATA FOR THE ROTARY KILN AND SECONDARY COMBUSTOR

Parameter (units)	Design Value	Operating Value					
		Sample Set #1 (11:20 am)[a] (11:45 am)[a]	Sample Set #2 (12:15 pm)[a] (12:45 pm)[a]	Sample Set #3 (1:15 pm)[a] (1:45 pm)[a]	Sample Set #4 (2:15 pm)[a] (2:45 pm)[a]	Sample Set #5 (3:15 pm)[a] (3:45 pm)[a]	Sample Set #6 (4:15 pm)[a] (4:45 pm)[a]
Kiln Outlet Temperature (^{o}F)	1,000-1,700	1,391 1,255	1,393 1,405	1,360 1,604	1,425 1,413	1,452 1,450	1,207 1,551
Rotary Kiln Solid Waste[b] Feed Rate (lbs/minute)	NS	32 32	32 32	32 32	32 32	32 32	32 32
Kiln Rotational Speed[c] (RPM)	0.2-0.6	0.45 0.45	0.45 0.45	0.45 0.45	0.25 0.45	0.23 0.27	0.27 0.1
BTU Loading - Rotary Kiln (MMBTU/hour)	11	16 17	17 16	16 16	16 16	16 16	16 15
Secondary Combustor Temperature (^{o}F)	1,800-2,200	2,025 2,021	2,056 2,142	2,132 1,990	2,093 2,119	2,123 2,126	2,006 1,877
Secondary Combustor Liquid Waste[d] Feed Rate (lbs/minute)	NS	18.2 27.7	29.2 27.7	29.4 32.3	25.9 25.6	29.6 25.4	13.4 1.2
BTU Loading-Secondary Combustor (MMBTU/hour)	19	10 14	15 14	15 17	14 13	15 15	11 7

Note: Kiln solids residence time is estimated to be 30-60 minutes. Secondary combustor residence time is estimated to be approximately 3 seconds. Both estimates are based on discussions with plant personnel.

NS - Not specified.

[a] Time of data collection.

[b] This solid represents F024 from plants C and D and the sludge that were treated by the rotary kiln incineration system.

[c] The kiln rotational speed was decreased during the run to allow for a longer residence time of the kiln solids and to lower the temperature of the waste heat boiler.

[d] This liquid represents F024 from plants A and B and the organic liquid that were treated by the rotary kiln incineration system.

5.0 IDENTIFICATION OF THE PROPOSED BEST DEMONSTRATED AND AVAILABLE TECHNOLOGY (BDAT)

This section presents the Agency's rationale for determining the proposed best demonstrated available technology (BDAT) for K017 nonwastewaters and wastewaters. Proposed BDAT for K017 has been determined to be incineration.

To determine BDAT, the Agency examines all available treatment performance data on technologies that are identified as demonstrated for the waste of concern or for a waste similar to the waste of concern to evaluate whether one or more of the technologies performs significantly better than the others. If data are available for only one technology for treating a waste, then that technology is "best". When data are available for more than one treatment technology, the "best" performing treatment technology is determined by an analysis of variance (ANOVA) test. (The ANOVA test is discussed in EPA's Methodology for Developing BDAT Treatment Standards (Reference 8).)

The treatment technology that is found to perform best on a particular waste stream is then evaluated to determine whether it is "available". To be available, the technology must (1) be commercially available, and (2) provide "substantial" treatment of the waste, as determined through evaluation of treatment performance data that have been corrected for accuracy. In determining whether treatment is substantial, EPA may consider data on a treatment technology's performance on a waste similar to the waste in

question, provided that the similar waste is at least as difficult to treat. If it is determined that the best performing treatment technology is not available, then the next best technology is evaluated to determine whether it is "available", and so on.

5.1 Review of Treatment Performance Data

The available treatment performance data presented in Section 4.0 were reviewed and assessed to determine whether they represent operation of a well-designed and well-operated system, whether sufficient quality assurance/quality control measures were employed to ensure the accuracy of the data, and whether the appropriate measures of performance were used to assess the performance of the treatment technology.

The treatment performance data and the design and operating data collected during the test of rotary kiln incineration of F024 were reviewed for the points described above. The appropriate measure of performance (total constituent concentration for incineration) was used to assess the treatment system.

Neither K017 nor F024 treatment performance data are available for liquid injection and fluidized-bed incineration. However, the Agency believes that well-designed and well-operated liquid injection and fluidized-bed incineration systems can meet the proposed BDAT treatment standards established for organic constituents in K017.

5.2 Accuracy Correction of Treatment Performance Data

As part of the review of treatment performance data for rotary kiln incineration, the data were adjusted to take into account any analytical interferences associated with the chemical makeup of the samples. Generally, performance data were corrected for accuracy as follows: (1) a matrix spike recovery was determined, as explained below, for each BDAT List constituent detected in the untreated or treated waste; (2) an accuracy correction factor was determined for each of the above constituents by dividing 100 by the matrix spike recovery (expressed as a percentage) for that constituent; and (3) the reported concentration of each BDAT List constituent detected in the untreated or treated waste was corrected by multiplying the concentration by the corresponding accuracy correction factor.

Matrix spike recoveries are developed by analyzing a sample of a treated waste for a constituent and then re-analyzing the sample after the addition of a known amount of the same constituent (i.e., spike) to the sample. The matrix spike recovery represents the total amount of constituent recovered after spiking minus the initial concentration of the constituent in the sample, and the result divided by the spike concentration of the constituent.

5.2.1 Nonwastewaters

Matrix spike recoveries used to calculate accuracy correction factors for adjustment of the treatment performance data for the kiln ash

residue of F024 are presented in Table C-1 of Appendix C of this background document. Duplicate matrix spikes were performed for some BDAT List constituents in kiln ash. If duplicate matrix spikes were performed for a constituent, the matrix spike recovery used for that constituent was the lower of the two values from the first matrix spike and the duplicate spike.

Where a matrix spike was not performed for a constituent, the matrix spike recovery for that constituent was derived from the average matrix spike recoveries of the appropriate group of constituents (e.g., volatile organics) for which recovery data were available. In these cases, the matrix spike recoveries for all volatile organics, semivolatile organics, or dioxins/furans from the first matrix spike were averaged separately. Similarly, an average matrix spike recovery was calculated for the duplicate matrix spike recoveries. The lower of the two average matrix spike recoveries of the volatile, semivolatile, or dioxin/furan group was used for any volatile, semivolatile, or dioxin/furan constituent for which no matrix spike was performed.

Using this method, the accuracy correction factors were calculated for nonwastewater (rotary kiln ash) data and are presented in Table C-3 of Appendix C of this document. The concentrations of each BDAT List constituent detected in either the untreated F024 or the rotary kiln ash were corrected for accuracy and are presented in Table 5-1. Constituent concentrations in the kiln ash residue were not adjusted to values below their detection limit. If accuracy correction resulted in a value less than the detection limit for a

Table 5-1

BDAT LIST CONSTITUENT
CONCENTRATIONS IN KILN ASH RESIDUE, CORRECTED FOR ACCURACY[a]

BDAT List Constituent	Corrected Total Concentration in the F024 Rotary Kiln Incinerator Ash (mg/kg) Sample Set 1	2	3	4	5	6
Volatiles						
222. Acetone	0.010	0.010	0.010	0.010	0.010	0.010
10. 2-Chloro-1,3-butadiene	0.100	0.100	0.100	0.100	0.100	0.100
16. 3-Chloropropene	0.100	0.100	0.100	0.100	0.100	0.100
20. trans-1,4-Dichloro-2-butene	0.100	0.100	0.100	0.100	0.100	0.100
21. Dichlorodifluoromethane	0.710	1.400	1.500	1.600	1.700	1.400
23. 1,2-Dichloroethane	0.005	0.005	0.005	0.005	0.005	0.005
26. 1,2-Dichloropropane	0.005	0.005	0.005	0.005	0.005	0.005
27. trans-1,3-Dichloropropene	0.005	0.005	0.005	0.005	0.005	0.005
28. cis-1,3-Dichloropropene	0.005	0.005	0.005	0.005	0.005	0.005
34. Methyl ethyl ketone	0.010	0.010	0.010	0.010	0.010	0.010
42. Tetrachloroethene	0.005	0.005	0.005	0.005	0.005	0.005
46. 1,1,2-Trichloroethane	0.005	0.005	0.005	0.005	0.005	0.005
49. 1,2,3-Trichloropropane	0.005	0.005	0.005	0.005	0.005	0.005
Semivolatiles						
59. Benz(a)anthracene	0.632	0.632	0.666	0.632	0.632	0.632
62. Benzo(a)pyrene	0.632	0.632	0.666	0.632	0.632	0.632
63. Benzo(b)fluoranthene	0.632	0.632	0.666	0.632	0.632	0.632
64. Benzo(ghi)perylene	0.632	0.632	0.666	0.632	0.632	0.632
65. Benzo(k)fluoranthene	0.632	0.632	0.666	0.632	0.632	0.632
68. Bis(2-chloroethyl)ether	0.632	0.632	0.666	0.632	0.632	0.632
70. Bis(2-ethylhexyl)phthalate	0.632	0.632	0.666	0.632	0.632	0.632
80. Chrysene	0.632	0.632	0.666	0.632	0.632	0.632
88. 1,4-Dichlorobenzene	0.462	0.462	0.488	0.462	0.462	0.462
92. Diethyl phthalate	1.264	1.264	1.280	1.145	0.854	2.164
110. Hexachlorobenzene	0.632	0.632	0.666	0.632	0.632	0.632
113. Hexachloroethane	0.632	0.632	0.666	0.632	0.632	0.632

NA - Not analyzed.

[a]This table presents data for the BDAT List constituents detected in either the untreated F024 from plants A, B, C, and D or the rotary kiln ash. These data were obtained by multiplying the concentration found in the incinerator ash (Section 4.0) by the accuracy correction factor for that constituent (Appendix C.)

Table 5-1 (Continued)

BDAT LIST CONSTITUENT
CONCENTRATIONS IN KILN ASH RESIDUE, CORRECTED FOR ACCURACY[a]

BDAT List Constituent	Corrected Total Concentration in the F024 Rotary Kiln Incinerator Ash (mg/kg) Sample Set 1	2	3	4	5	6
Semivolatiles (Cont.)						
116. Indeno(1,2,3-cd)pyrene	0.632	0.632	0.666	0.632	0.632	0.632
141. Phenanthrene	0.632	0.632	0.666	0.632	0.632	0.632

NA - Not analyzed.

[a]This table presents data for the BDAT List constituents detected in either the untreated F024 from plants A, B, C, and D or the rotary kiln ash. These data were obtained by multiplying the concentration found in the incinerator ash (Section 4.0) by the accuracy correction factor for that constituent (Appendix C).

constituent, the accuracy-corrected concentration was set equal to the detection limit.

5.2.2 Wastewaters

Matrix spike recoveries used to calculate accuracy correction factors for adjustment of the treatment performance data for the combustion gas scrubber water are presented in Table C-2 of Appendix C. If duplicate matrix spikes were performed for a constituent, the matrix spike recovery used for that constituent was the lower of the two values from the first matrix spike and the duplicate spike.

Where a matrix spike was not performed for a constituent, the matrix spike recovery for that constituent was derived from the average matrix spike recoveries of the appropriate group of constituents (e.g., volatile organics) for which recovery data were available. In these cases, the matrix spike recoveries for all volatile organics, semivolatile organics, or dioxins/furans from the first matrix spike were averaged. Similarly, an average matrix spike recovery was calculated for the duplicate matrix spike recoveries. The lower of the two average matrix spike recoveries of the volatile, semivolatile, or dioxin/furan group was used for any volatile, semivolatile, or dioxin/furan constituent for which no matrix spike was performed.

Using this method, the accuracy correction factors were calculated for wastewater (scrubber water) data and are presented in Table C-3 of

Appendix C of this document. The concentrations of each BDAT List constituent detected in either the untreated F024 or the rotary kiln ash were corrected for accuracy and are presented in Table 5-2. Constituent concentrations in the scrubber water residual were not adjusted to values below the detection limit for that constituent. If accuracy correction resulted in a value less than the detection limit, the accuracy-corrected value was set equal to the detection limit.

5.3 Statistical Comparison of Treatment Performance Data

In cases where the Agency has treatment performance data from more than one technology, EPA uses the statistical method known as the analysis of variance (ANOVA) test (discussed in EPA's Methodology for Developing BDAT Treatment Standards (Reference 8)), to determine if one technology performs significantly better than the rest. For F024, the Agency has treatment performance data for only one treatment system and therefore, an ANOVA comparison is not appropriate.

5.4 Available Treatment Technologies

The demonstrated technology for treatment of K017, incineration, is considered to be commercially available. Furthermore, the Agency has determined that this technology will provide substantial treatment of F024 and therefore, K017 also. Consequently, this technology is considered available for treatment of K017.

Table 5-2

BDAT LIST CONSTITUENT
CONCENTRATIONS IN SCRUBBER WATER, CORRECTED FOR ACCURACY[a]

BDAT List Constituent	Corrected Total Concentration in the F024 Combustion Gas Scrubber Water (mg/l) Sample Set 1	2	3	4	5	6
Volatiles						
222. Acetone	0.010	0.010	0.010	0.010	0.010	0.010
6. Bromomethane	0.010	0.010	0.010	0.010	0.010	0.032
10. 2-Chloro-1,3-butadiene	0.101	0.101	0.101	0.101	0.101	0.101
12. Chloroethane	0.010	0.010	0.010	0.010	0.010	0.031
15. Chloromethane	0.010	0.010	0.010	0.010	0.010	0.020
16. 3-Chloropropene	0.101	0.101	0.101	0.101	0.101	0.101
20. trans-1,4-Dichloro-2-butene	0.101	0.101	0.101	0.101	0.101	0.101
21. Dichlorodifluoromethane	0.010	0.010	0.292	0.363	0.403	0.444
23. 1,2-Dichloroethane	0.005	0.005	0.005	0.005	0.005	0.005
26. 1,2-Dichloropropane	0.005	0.005	0.005	0.005	0.005	0.005
27. trans-1,3-Dichloropropene	0.005	0.005	0.005	0.005	0.005	0.005
28. cis-1,3-Dichloropropene	0.005	0.005	0.005	0.005	0.005	0.005
34. Methyl ethyl ketone	0.010	0.010	0.010	0.010	0.010	0.010
42. Tetrachloroethene	0.005	0.005	0.005	0.005	0.005	0.005
46. 1,1,2-Trichloroethane	0.005	0.005	0.005	0.005	0.005	0.005
49. 1,2,3-Trichloropropane	0.005	0.005	0.005	0.005	0.005	0.005
Semivolatiles						
59. Benz(a)anthracene	0.014	0.014	0.013	0.012	0.013	0.013
62. Benzo(a)pyrene	0.014	0.014	0.013	0.012	0.013	0.013
63. Benzo(b)fluoranthene	0.014	0.014	0.013	0.012	0.013	0.013
64. Benzo(ghi)perylene	0.014	0.014	0.013	0.012	0.013	0.013
65. Benzo(k)fluoranthene	0.014	0.014	0.013	0.012	0.013	0.013
68. Bis(2-chloroethyl)ether	0.014	0.014	0.013	0.012	0.013	0.013
70. Bis(2-ethylhexyl)phthalate	0.014	0.014	0.013	0.012	0.013	0.013
80. Chrysene	0.014	0.014	0.013	0.012	0.013	0.013

NA - Not analyzed.

[a]This table presents data for the BDAT List constituents detected in either the untreated F024 from plants A, B, C, and D or the scrubber water. These data were obtained by multiplying the concentration found in the scrubber water (Section 4.0) by the accuracy correction factor for that constituent (Appendix C).

Table 5-2 (Continued)

BDAT LIST CONSTITUENT
CONCENTRATIONS IN SCRUBBER WATER, CORRECTED FOR ACCURACY[a]

BDAT List Constituent	Corrected Total Concentration in the F024 Combustion Gas Scrubber Water (mg/l) Sample Set 1	2	3	4	5	6
Semivolatiles (Continued)						
88. 1,4-Dichlorobenzene	0.021	0.021	0.019	0.017	0.019	0.019
92. Diethyl phthalate	0.014	0.014	0.013	0.012	0.066	0.013
110. Hexachlorobenzene	0.014	0.014	0.013	0.012	0.013	0.013
113. Hexachloroethane	0.014	0.014	0.013	0.012	0.013	0.013
116. Indeno(1,2,3-cd)pyrene	0.014	0.014	0.013	0.012	0.013	0.013
141. Phenanthrene	0.014	0.014	0.013	0.012	0.013	0.013

NA - Not analyzed.

[a]This table presents data for the BDAT List constituents detected in either the untreated F024 from plants A, B, C, and D or the scrubber water. These data were obtained by multiplying the concentration found in the scrubber water (Section 4.0) by the accuracy correction factor for that constituent (Appendix C).

5.5 Proposed BDAT for K017

As discussed above, incineration has been determined to be demonstrated and available. Because the Agency does not have treatment performance data for any other technologies treating K017 or similar wastes, this treatment is the best. Therefore, the proposed best demonstrated and available technology (BDAT) for K017 has been determined to be incineration. In addition, this proposed BDAT technology does not preclude a facility from utilizing recycle or reuse operations in accordance with 40 CFR Part 261.2. Also, it does not preclude the use of other treatment technologies that can achieve the treatment standards.

6.0 SELECTION OF PROPOSED REGULATED CONSTITUENTS

This section presents the methodology and rationale for selection of constituents being proposed for regulation in K017 nonwastewaters and wastewaters. Generally, regulated constituents must satisfy the following criteria:

1. They must be on the BDAT List of constituents. (Presence on the BDAT List means that approved methods exist for analyzing the constituent in treated waste matrices.)

2. They must be present in or be suspected of being present in the untreated waste. For example, analytical difficulties may prevent a constituent from being identified in the untreated waste, but its identification in a treatment residual may lead the Agency to conclude that it is present in the untreated waste.

3. Where treatment performance data are transferred, the regulated constituents must be no more difficult to treat than the constituents from which performance data are transferred. Factors used to assess ease of treatment vary according to the technology of concern. For example, for incineration, the factors include bond dissociation energy and boiling point.

The Agency initially considered all constituents on the BDAT List for proposed regulation. Table 6-1, at the end of this section, summarizes available waste characterization data for the BDAT List constituents in K017 (as derived from Table 2-2). Ranges of concentrations for constituents detected in the wastes are shown in the table. Constituents for which no analysis was performed are identified by "NA" (not analyzed).

Generally, a BDAT List constituent is deleted from consideration for regulation if: (1) the constituent was not analyzed for in the untreated

waste; (2) detection limits or analytical results were not obtained for the constituent due to analytical problems; or (3) available treatment performance data for the constituent did not show effective treatment by BDAT.

6.1 BDAT List Constituents Not Selected for Proposed Regulation

BDAT List Constituents That Were Not Analyzed for in the Untreated Waste. Some constituents on the BDAT List were deleted from consideration for proposed regulation because these constituents were not analyzed for in the untreated waste (labeled "NA" in Table 6-1). These constituents were not analyzed because it is extremely unlikely that they would be present in the untreated waste based on the processes generating K017. These constituent types are metals, inorganics, organochlorine pesticides, phenoxyacetic acid herbicides, organophosphorus insecticides, PCBs, and dioxins and furans.

Constituents for Which Detection Limits or Analytical Results Were Not Obtained Due to Analytical Problems. There were no BDAT List constituents that were deleted from proposed regulation based on this consideration.

Constituents for Which Available Treatment Performance Data Did Not Show Effective Treatment by BDAT. There were no BDAT List constituents that were deleted from proposed regulation based on this consideration.

Table 6-1

STATUS OF BDAT LIST CONSTITUENTS IN UNTREATED K017

BDAT List Constituent	Detection Status Concentration in Untreated Waste (%)
Volatiles	**K017**
222. Acetone	NA
1. Acetonitrile	NA
2. Acrolein	NA
3. Acrylonitrile	NA
4. Benzene	NA
5. Bromodichloromethane	NA
6. Bromomethane	NA
223. n-Butyl alcohol	NA
7. Carbon tetrachloride	NA
8. Carbon disulfide	NA
9. Chlorobenzene	NA
10. 2-Chloro-1,3-butadiene	NA
11. Chlorodibromomethane	NA
12. Chloroethane	NA
13. 2-Chloroethyl vinyl ether	NA
14. Chloroform	NA
15. Chloromethane	NA
16. 3-Chloropropene	NA
17. 1,2-Dibromo-3-chloropropane	NA
18. 1,2-Dibromoethane	NA
19. Dibromomethane	NA
20. trans-1,4-Dichloro-2-butene	NA
21. Dichlorodifluoromethane	NA
22. 1,1-Dichloroethane	NA
23. 1,2-Dichloroethane	NA
24. 1,1-Dichloroethylene	NA
25. trans-1,2-Dichloroethene	NA
26. 1,2-Dichloropropane	0.1-1
27. trans-1,3-Dichloropropene	NA
28. cis-1,3-Dichloropropene	NA
29. 1,4-Dioxane	NA
224. 2-Ethoxyethanol	NA
225. Ethyl acetate	NA
226. Ethyl benzene	NA

NA - Not analyzed.

Table 6-1 (Continued)

STATUS OF BDAT LIST CONSTITUENTS IN UNTREATED K017

BDAT List Constituent	Detection Status Concentration in Untreated Waste (%)
	K017
Volatiles (Continued)	
30. Ethyl cyanide	NA
227. Ethyl ether	NA
31. Ethyl methacrylate	NA
214. Ethylene oxide	NA
32. Iodomethane	NA
33. Isobutyl alcohol	NA
37. Methacrylonitrile	NA
228. Methanol	NA
34. Methyl ethyl ketone	NA
229. Methyl isobutyl ketone	NA
35. Methyl methacrylate	NA
38. Methylene chloride	NA
230. 2-Nitropropane	NA
39. Pyridine	NA
40. 1,1,1,2-Tetrachloroethane	NA
41. 1,1,2,2-Tetrachloroethane	NA
42. Tetrachloroethene	NA
43. Toluene	NA
44. Tribromomethane	NA
45. 1,1,1-Trichloroethane	NA
46. 1,1,2-Trichloroethane	NA
47. Trichloroethene	NA
48. Trichloromonofluoromethane	NA
49. 1,2,3-Trichloropropane	NA
231. 1,1,2-Trichloro-1,2,2-trifluoroethane	<0.01-70
50. Vinyl chloride	NA
215. 1,2-Xylene	NA
216. 1,3-Xylene	NA
217. 1,4-Xylene	NA

NA - Not analyzed.

Table 6-1 (Continued)

STATUS OF BDAT LIST CONSTITUENTS IN UNTREATED K017

BDAT List Constituent	Detection Status Concentration in Untreated Waste (%)
Semivolatiles	
51. Acenaphthalene	NA
52. Acenaphthene	NA
53. Acetophenone	NA
54. 2-Acetylaminofluorene	NA
55. 4-Aminobiphenyl	NA
56. Aniline	NA
57. Anthracene	NA
58. Aramite	NA
59. Benz(a)anthracene	NA
218. Benzal chloride	NA
60. Benzenethiol	NA
62. Benzo(a)pyrene	NA
63. Benzo(b)fluoranthene	NA
64. Benzo(ghi)perylene	NA
65. Benzo(k)fluoranthene	NA
66. p-Benzoquinone	NA
67. Bis(2-chloroethoxy)methane	NA
68. Bis(2-chloroethyl)ether	NA
69. Bis(2-chloroisopropyl)ether	14
70. Bis(2-ethylhexyl)phthalate	NA
71. 4-Bromophenyl phenyl ether	NA
72. Butyl benzyl phthalate	NA
73. 2-sec-Butyl-4,6-dinitrophenol	NA
74. p-Chloroaniline	NA
75. Chlorobenzilate	NA
76. p-Chloro-m-cresol	NA
77. 2-Chloronaphthalene	NA
78. 2-Chlorophenol	NA
79. 3-Chloropropionitrile	NA
80. Chrysene	NA
81. ortho-Cresol	NA
82. para-Cresol	NA
232. Cyclohexanone	NA
83. Dibenz(a,h)anthracene	NA
84. Dibenzo(a,e)pyrene	NA
85. Dibenzo(a,i)pyrene	NA

NA - Not analyzed.

Table 6-1 (Continued)

STATUS OF BDAT LIST CONSTITUENTS IN UNTREATED K017

BDAT List Constituent	Detection Status Concentration in Untreated Waste (%)
Semivolatiles (Continued)	
86. m-Dichlorobenzene	NA
87. o-Dichlorobenzene	NA
88. p-Dichlorobenzene	NA
89. 3,3'-Dichlorobenzidine	NA
90. 2,4-Dichlorophenol	NA
91. 2,6-Dichlorophenol	NA
92. Diethyl phthalate	NA
93. 3,3-Dimethoxybenzidine	NA
94. p-Dimethylaminoazobenzene	NA
95. 3,3'-Dimethylbenzidine	NA
96. 2,4-Dimethylphenol	NA
97. Dimethyl phthalate	NA
98. Di-n-butyl phthalate	NA
99. 1,4-Dinitrobenzene	NA
100. 4,6-Dinitro-o-cresol	NA
101. 2,4-Dinitrophenol	NA
102. 2,4-Dinitrotoluene	NA
103. 2,6-Dinitrotoluene	NA
104. Di-n-octyl phthalate	NA
105. Di-n-propylnitrosamine	NA
106. Diphenylamine	NA
219. Diphenylnitrosamine	NA
107. 1,2-diphenylhydrazine	NA
108. Fluoranthene	NA
109. Fluorene	NA
110. Hexachlorobenzene	NA
111. Hexachlorobutadiene	NA
112. Hexachlorocyclopentadiene	NA
113. Hexachloroethane	NA
114. Hexachlorophene	NA
115. Hexachloropropene	NA
116. Indeno(1,2,3-cd)pyrene	NA
117. Isosafrole	NA
118. Methapyrilene	NA
119. 3-Methylcholanthrene	NA
120. 4,4'-Methylenebis (2-chloroaniline)	NA

NA - Not analyzed.

Table 6-1 (Continued)

STATUS OF BDAT LIST CONSTITUENTS IN UNTREATED K017

BDAT List Constituent	Detection Status Concentration in Untreated Waste (%)
Semivolatiles (Continued)	
36. Methyl methanesulfonate	NA
121. Naphthalene	NA
122. 1,4-Naphthoquinone	NA
123. 1-Naphthylamine	NA
124. 2-Naphthylamine	NA
125. p-Nitroaniline	NA
126. Nitrobenzene	NA
127. 4-Nitrophenol	NA
128. N-Nitrosodi-n-butylamine	NA
129. N-Nitrosodiethylamine	NA
130. N-Nitrosodimethylamine	NA
131. N-Nitrosomethylethylamine	NA
132. N-Nitrosomorpholine	NA
133. N-Nitrosopiperidine	NA
134. N-Nitrosopyrrolidine	NA
135. 5-Nitro-o-toluidine	NA
136. Pentachlorobenzene	NA
137. Pentachloroethane	NA
138. Pentachloronitrobenzene	NA
139. Pentachlorophenol	NA
141. Phenanthrene	NA
142. Phenol	NA
220. Phthalic anhydride	NA
143. 2-Picoline	NA
144. Pronamide	NA
145. Pyrene	NA
146. Resorcinol	NA
147. Safrole	NA
148. 1,2,4,5-Tetrachlorobenzene	NA
149. 2,3,4,6-Tetrachlorophenol	NA
150. 1,2,4-Trichlorobenzene	NA
151. 2,4,5-Trichlorophenol	NA
152. 2,4,6-Trichlorophenol	NA
153. Tris(2,3-dibromopropyl)phosphate	NA

NA - Not analyzed.

Table 6-1 (Continued)

STATUS OF BDAT LIST CONSTITUENTS IN UNTREATED K017

BDAT List Constituent	Detection Status Concentration in Untreated Waste (%)
Metals	
154. Antimony	NA
155. Arsenic	NA
156. Barium	NA
157. Beryllium	NA
158. Cadmium	NA
159. Chromium (total)	NA
221. Chromium (hexavalent)	NA
160. Copper	NA
161. Lead	NA
162. Mercury	NA
163. Nickel	NA
164. Selenium	NA
165. Silver	NA
166. Thallium	NA
167. Vanadium	NA
168. Zinc	NA
	NA
Inorganics	
169. Cyanide	NA
170. Fluoride	NA
171. Sulfide	NA
	NA
Organochlorine Pesticides	
172. Aldrin	NA
173. alpha-BHC	NA
174. beta-BHC	NA
175. delta-BHC	NA
176. gamma-BHC	NA
177. Chlordane	NA
178. DDD	NA
179. DDE	NA
180. DDT	NA
181. Dieldrin	NA
182. Endosulfan I	NA
183. Endosulfan II	NA

NA - Not analyzed.

Table 6-1 (Continued)

STATUS OF BDAT LIST CONSTITUENTS IN UNTREATED K017

BDAT List Constituent	Detection Status Concentration in Untreated Waste (%)
Organochlorine Pesticides (Continued)	
184. Endrin	NA
185. Endrin aldehyde	NA
186. Heptachlor	NA
187. Heptachlor epoxide	NA
188. Isodrin	NA
189. Kepone	NA
190. Methoxychlor	NA
191. Toxaphene	NA
	NA
Phenoxyacetic Acid Herbicides	
192. 2,4-Dichlorophenoxyacetic acid	NA
193. Silvex	NA
194. 2,4,5-T	NA
	NA
Organophosphorus Insecticides	
195. Disulfoton	NA
196. Famphur	NA
197. Methyl parathion	NA
198. Parathion	NA
199. Phorate	NA
	NA
PCBs	NA
200. Aroclor 1016	NA
201. Aroclor 1221	NA
202. Aroclor 1232	NA
203. Aroclor 1242	NA
204. Aroclor 1248	NA
205. Aroclor 1254	NA
206. Aroclor 1260	NA
	NA

NA - Not analyzed.

Table 6-1 (Continued)

STATUS OF BDAT LIST CONSTITUENTS IN UNTREATED K017

BDAT List Constituent	Detection Status Concentration in Untreated Waste (%)
Dioxins and Furans	
207. Hexachlorodibenzo-p-dioxins	NA
208. Hexachlorodibenzofuran	NA
209. Pentachlorodibenzo-p-dioxins	NA
210. Pentachlorodibenzofuran	NA
211. Tetrachlorodibenzo-p-dioxins	NA
212. Tetrachlorodibenzofuran	NA
213. 2,3,7,8-Tetrachlorodibenzo-p-dioxin	NA

NA - Not analyzed.

6.2 BDAT List Constituents Selected for Proposed Regulation

All of the BDAT List organic constituents that were further considered for regulation in K017 nonwastewaters and wastewaters have been selected for proposed regulation. Table 6-2, at the end of this section, presents the three BDAT List constituents selected for proposed regulation in K017 nonwastewaters and wastewaters.

6.3 Non-BDAT Constituents Deleted from Consideration for Proposed Regulation

Of the six constituents of concern identified in the K017 characterization data, three are BDAT List constituents and three are non-BDAT List constituents. The three non-BDAT List constituents of concern are bis(2-chloromethyl)ether, epichlorohydrin, and dichloropropanol. While these non-BDAT List constituents are present in K017 at high concentrations, there are currently no EPA-approved methods for analyzing for these constituents in the K017 matrix. Therefore, the Agency believes that these non-BDAT List constituents should be deleted from consideration for proposed regulation.

Table 6-2

BDAT LIST CONSTITUENTS SELECTED FOR PROPOSED REGULATION IN K017
NONWASTEWATERS AND WASTEWATERS

Nonwastewaters	Wastewaters
26. 1,2-Dichloropropane	26. 1,2-Dichloropropane
49. 1,2,3-Trichloropropane	49. 1,2,3-Trichloropropane
68. Bis(2-chloroethyl)ether	68. Bis(2-chloroethyl)ether

7.0 CALCULATION OF PROPOSED BDAT TREATMENT STANDARDS

The Agency bases numerical treatment standards for regulated constituents on the performance of well-designed and well-operated BDAT treatment systems. These standards must account for analytical limitations in available treatment performance data, and the data must be adjusted for variabilities related to treatment, sampling, and analytical techniques and procedures. This section presents the calculation of proposed treatment standards for K017 nonwastewaters and wastewaters for the constituents selected for proposed regulation in Section 6.0 using the available treatment performance data from the BDAT treatment technology. A discussion of how the proposed treatment standards for K017 nonwastewaters and wastewaters were calculated is included in this section.

Proposed BDAT treatment standards for K017 nonwastewaters and wastewaters are based on the demonstrated technology of incineration (rotary kiln, fluidized-bed, or liquid injection).

As noted in Section 5.0 of this background document, before treatment standards are calculated, the treatment performance data are corrected to account for analytical interferences associated with the chemical matrices of the samples. A complete discussion of the accuracy correction of treatment data is provided in Appendix C.

After treatment performance data are corrected for accuracy, the arithmetic average of the corrected data is calculated for each regulated constituent. In cases where the constituent is not detected above its detection limit, the detection limit is used to calculate the average constituent concentration in the treated waste. Table 7-1, at the end of this section, presents the average of the corrected treatment performance data for each constituent proposed for regulation in K017 nonwastewaters and wastewaters.

The next step in calculating treatment standards is to determine the variability factor (VF) for each regulated constituent. The variability factor accounts for the variability inherent in treatment system performance, treatment residual collection, and treatment sample analysis. (For more information on calculation of variability factors, see EPA's Methodology for Developing BDAT Treatment Standards (Reference 8).) Variability factors for the constituents proposed for regulation in K017 are shown in Table 7-1.

Finally, the treatment standard is calculated for each regulated constituent by multiplying the average of the corrected treatment performance values by the variability factor for the constituent. Proposed treatment standards for K017 are also presented in Table 7-1 and are discussed in greater detail in Sections 7.1 and 7.2.

7.1 Calculation of Proposed Treatment Standards for K017 Nonwastewaters

Treatment performance data from rotary kiln incineration of K017 is not available. Therefore, the Agency is transferring performance data from

treatment of F024 to K017. The rationale for this transfer was presented in Section 4.0

Incineration generally results in the generation of ash (a nonwastewater form of K017) and combustion gas scrubber water (a wastewater form of K017). The best measure of performance for a destruction technology, such as incineration, is the total amount of each constituent of concern remaining after treatment. Therefore, proposed BDAT treatment standards for organic constituents in K017 nonwastewaters were calculated based on total constituent concentration data transferred from F024 incinerator ash.

Proposed treatment standards for organic constituents in K017 nonwastewaters were calculated using six sets of data from rotary kiln incineration of F024. Tables 4-1 and 4-2 of Section 4.0 present the total concentration of each organic constituent detected in untreated F024 and the treated nonwastewater residual (ash). Treatment performance data for each constituent being proposed for regulation in K017 were transferred from data for the same constituent in F024.

7.2 Calculation of Treatment Standards for K017 Wastewaters

Treatment performance data for the wastewater residual, scrubber water, from rotary kiln incineration of K017 are not available. Therefore, the Agency is transferring performance data from treatment of F024 to develop proposed treatment standards for K017 wastewaters. The rationale for this transfer was presented in Section 4.0.

The best measure of performance for a destruction technology, such as incineration, is the total amount of each constituent of concern remaining after treatment. Therefore, proposed BDAT treatment standards for organic constituents in K017 wastewaters were calculated based on total constituent concentration data transferred from F024 scrubber water.

Proposed treatment standards for organic constituents in K017 wastewaters were calculated using six sets of data from rotary kiln incineration of F024. Tables 4-1 and 4-3 of Section 4.0 present the total concentrations of each organic constituent in the untreated F024 and the treated wastewater residual, respectively. Treatment performance data for each constituent being proposed for regulation in K017 were transferred from data for the same constituent in F024.

Table 7-1

CALCULATION OF PROPOSED TREATMENT STANDARDS FOR ORGANIC CONSTITUENTS IN K017 NONWASTEWATERS AND WASTEWATERS

	Regulated BDAT List Constituent (SW-846 Method Number)	F024 Constituent From Which Treatment Data Were Transferred	Arithmetic Average of Corrected Treatment Performance Values (ppm)	Variability Factor (VF)	Treatment Standard[a] (Average X VF) (ppm)
	NONWASTEWATERS				
	Volatiles (8240) (Total Concentration)				
26.	1,2-Dichloropropane	1,2-Dichloropropane	0.005	2.8	0.014
49.	1,2,3-Trichloropropane	1,2,3-Trichloropropane	0.005	2.8	0.014
	Semivolatiles (8270) (Total Concentration)				
68.	Bis(2-chloroethyl)ether	Bis(2-chloroethyl)ether	0.638	2.8	1.78
	WASTEWATERS				
	Volatiles (8240) (Total Concentration)				
26.	1,2-Dichloropropane	1,2-Dichloropropane	0.005	2.8	0.014
49.	1,2,3-Trichloropropane	1,2,3-Trichloropropane	0.005	2.8	0.014
	Semivolatiles (8270) (Total Concentration)				
68.	Bis(2-chloroethyl)ether	Bis(2-chloroethyl)ether	0.013	2.8	0.037

[a] = The values shown in this table for treatment standards have been rounded off to show significant figures only.

8.0 ACKNOWLEDGEMENTS

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The following personnel from Radian Corporation were involved in preparing this document: Mr. John Williams, Program Manager; Ms. Lori Stoll, Project Director; and Ms. Mary Willett of the Radian engineering team.

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Appendix A

WASTE CHARACTERISTICS AFFECTING PERFORMANCE

Table A-1

BOILING POINTS FOR CONSTITUENTS OF CONCERN

	Constituent	Boiling Point (°C)	Reference
26.	1,2-Dichloropropane	96.4	16
49.	1,2,3-Trichloropropane	156.8	16
68.	Bis(2-chloroethyl)ether	178	17
	Bis(2-chloromethyl)ether	104	16
	Epichlorohydrin	-16.5	17
	Dichloropropanol	28	17

Source: Merck Index (Reference 17).

Table A-2

CALCULATED BOND DISSOCIATION ENERGIES FOR CONSTITUENTS OF CONCERN

	Constituent	Bond Dissociation Energy (kcal/mole)
26.	1,2-Dichloropropane	930
49.	1,2,3-Trichloropropane	910
68.	Bis(2-chloroethyl)ether	1,290
	Bis(2-chloromethyl)ether	720
	Epichlorohydrin	910
	Dichloropropanol	1,025

Source: CRC Handbook of Chemistry and Physics (Reference 16).

Appendix B

F024 PLANT CODES

Appendix C

ACCURACY CORRECTION OF TREATMENT PERFORMANCE DATA

Appendix C

ACCURACY CORRECTION OF TREATMENT PERFORMANCE DATA

The treatment performance data used to determine proposed treatment standards for K017 were adjusted to account for analytical interferences associated with the chemical matrices of the samples. Generally, treatment performance data were corrected for accuracy as follows: (1) a matrix spike recovery was determined for each BDAT List constituent detected in the untreated or treated waste; (2) an accuracy correction factor was determined for each of the above constituents by dividing 100 by the matrix spike recovery (percent) for that constituent; and (3) treatment performance data for each BDAT List constituent detected in the untreated or treated waste were corrected by multiplying the reported concentration of each constituent by its corresponding accuracy correction factor. The procedure for accuracy correction of the data is described in further detail below.

Matrix spike recoveries are developed by analyzing a sample of a treated waste for a constituent and then re-analyzing the sample after the addition of a known amount of the same constituent (i.e., spike) to the sample. The matrix spike recovery represents the total amount of constituent recovered after spiking, minus the initial concentration of the constituent in the sample, and the result divided by the spike concentration of the constituent.

Matrix spike recoveries used to adjust the treatment performance data transferred to K017 are shown in Tables C-1 through C-2. Duplicate matrix spikes were performed for some BDAT List constituents. If a duplicate matrix spike was performed for a constituent, the matrix spike recovery used for that constituent was the lower of the two values from the first matrix spike and the duplicate spike.

Where a matrix spike was not performed for an organic constituent, the matrix spike recovery for that constituent was derived from the average matrix spike recoveries of the appropriate group of constituents (e.g., volatile or semivolatile organics) for which recovery data were available. In these cases, the matrix spike recoveries for all volatiles or semivolatiles from the first matrix spike were averaged. Similarly, an average matrix spike recovery was calculated for the duplicate matrix spike recoveries. The lower of the two average matrix spike recoveries of the volatile or semivolatile group was used for any volatile or semivolatile constituent for which no matrix spike was performed.

The accuracy correction factors for the data used to calculate K017 proposed treatment standards are presented in Table C-3. The corrected treatment concentrations for the constituents proposed for regulation in K017 nonwastewaters and wastewaters were presented in Tables 5-1 and 5-2 of Section 5.0.

Table C-1

MATRIX SPIKE RECOVERIES FOR KILN ASH RESIDUE (F024)

Spike Constituent	Original Amount Found[a] (ppm)	Sample Result			Duplicate Sample Result		
		Amount Spiked (ppm)	Amount Recovered (ppm)	Percent Recovery[b] (%)	Amount Spiked (ppm)	Amount Recovered (ppm)	Percent Recovery[b] (%)
VOLATILES							
4. Benzene	DL	0.050	0.063	126	0.050	0.065	130
9. Chlorobenzene	DL	0.050	0.045	90	0.050	0.054	108
24. 1,1-Dichloroethene	DL	0.050	0.040	80	0.050	0.061	122
43. Toluene	DL	0.050	0.085	170	0.050	0.111	222
47. Trichloroethene	DL	0.050	0.089	178	0.050	0.108	216
AVERAGE RECOVERY FOR VOLATILES				128.8			159.6
SEMIVOLATILES (BASE/NEUTRAL FRACTION)							
52. Acenaphthene	DL	0.050	0.015	30	0.050	0.044	88
88. 1,4-Dichlorobenzene	DL	0.050	0.036	72	0.050	0.045	90
102. 2,4-Dinitrotoluene	DL	0.050	0.019	38	0.050	0.050	100
105. N-Nitroso-di-n-propylamine	DL	0.050	0.055	110	0.050	0.059	118
145. Pyrene	DL	0.050	0.003	6	0.050	0.041	82
150. 1,2,4-Trichlorobenzene	DL	0.050	0.030	60	0.050	0.045	90
AVERAGE RECOVERY FOR SEMIVOLATILES (BASE/NEUTRAL FRACTION)				52.7			94.7

DL - Detection limit.

[a]For constituents not detected at or above the detection limit (DL), the original amount found is considered as zero in calculating percent recovery.

[b]Percent recovery = 100 x $(C_1-C_0)/C_t$, where C_1 = amount recovered, C_0 = original amount found, and C_t = amount spiked.

Table C-2

MATRIX SPIKE RECOVERIES FOR COMBUSTION GAS SCRUBBER DISCHARGE WATER (F024)

Spike Constituent	Original Amount Found[a] (ppm)	Sample Result			Duplicate Sample Result		
		Amount Spiked (ppm)	Amount Recovered (ppm)	Percent Recovery[b] (%)	Amount Spiked (ppm)	Amount Recovered (ppm)	Percent Recovery[b] (%)
VOLATILES							
4. Benzene	DL	0.050	0.043	86	0.050	0.045	90
9. Chlorobenzene	DL	0.050	0.055	110	0.050	0.056	112
24. 1,1-Dichloroethene	DL	0.050	0.040	80	0.050	0.040	80
43. Toluene	DL	0.050	0.057	114	0.050	0.057	114
47. Trichloroethene	DL	0.050	0.053	106	0.050	0.054	108
AVERAGE RECOVERY FOR VOLATILES				99.2			100.8
SEMIVOLATILES (BASE/NEUTRAL FRACTION)							
52. Acenaphthene	DL	0.050	0.039	78	0.050	0.032	64
88. 1,4-Dichlorobenzene	DL	0.050	0.032	64	0.050	0.029	58
102. 2,4-Dinitrotoluene	DL	0.050	0.057	114	0.050	0.057	114
105. N-Nitroso-di-n-propylamine	DL	0.050	0.066	132	0.050	0.058	116
145. Pyrene	DL	0.050	0.044	88	0.050	0.041	82
150. 1,2,4-Trichlorobenzene	DL	0.050	0.031	62	0.050	0.032	64
AVERAGE RECOVERY FOR SEMIVOLATILES (BASE/NEUTRAL FRACTION)				89.7			85.7

DL - Detection limit.
NA - Not analyzed.

[a]For constituents not detected at or above the detection limit (DL), the original amount found was considered as zero in calculating percent recovery.
[b]Percent recovery = 100 x $(C_1-C_0)/C_t$, where C_1 = amount recovered, C_0 = original amount found, and C_t = amount spiked.